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CONTROL OF APHIDS INJURIOUS TO ORCHARD FRUITS, CURRANT, GOOSEBERRY AND GRAPE

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28 OCT. 1920
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FARMERS' BULLETIN 1128
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. June, 1920

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1920

APHIDS are small, delicate, winged or wingless insects which feed upon plant juices, draining them from the foliage, fruit, twigs, or roots, through a beak pushed into the plant tissues.

Many kinds injure orchard fruits, currant, gooseberry, and grape. The most important are discussed in this bulletin.

Contact sprays, such as kerosene emulsion, soap washes, nicotine solutions, etc., must be used to kill aphids. Directions for preparing and applying them will be found on pages 39–45.

Stomach poisons, such as arsenate of lead, Paris green, and other arsenicals, are of no use against aphids.

Species which winter in the egg stage on the plants to be protected may be sprayed early in the spring as the buds are expanding, to kill the first brood and insure against injury later in the season.

Leaf-curling species, especially, should be treated with this bud spray in years when they are expected to be abundant. They can not be reached satisfactorily after the leaves have unfolded and the aphids have begun to be troublesome.

Those species which do not curl the leaves may be controlled readily by sprays when they are noted as becoming numerous.

Annual bud spraying in the case of the apple appears to be good orchard practice and, continued for a series of years, doubtless would prove profitable.

CONTROL OF APHIDS INJURIOUS TO ORCHARD FRUITS, CURRANT, GOOSEBERRY, AND GRAPE.[1]

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CONTENTS.

	Page.		Page.
Aphids in general	4	Control measures	38
Apple aphids	5	Insecticides	39
Quince aphids	14	Spraying for apple aphids	45
Pear aphids attacking the foliage	15	The delayed dormant treatment	45
Plum aphids	15	Control of aphids on plum, peach, cherry, etc	47
Cherry aphids	20	Control of aphids on currant, gooseberry, and grape	48
Peach aphids	25	Clean culture	48
Currant and gooseberry aphids	28		
Grape aphids attacking the foliage	36		
Natural enemies of aphids	37		

THE control of aphids, or plant-lice, is an ever recurring problem to the grower of orchard and bush fruits. Although cereal and forage crops furnish perhaps the most striking examples of the destruction wrought by aphids, practically no crop is free from attack by one or more of these small and delicate insects. During the past decade especially, aphid injury to orchard fruits, particularly the apple, has been on the increase.

The present bulletin treats of the aphids injurious to fruit and foliage of apple, quince, pear, plum, cherry, peach, currant, gooseberry, and grape. Forty-one species of aphids in all are discussed. The more important forms affecting a given fruit are considered first, and then follows a brief account of species known to infest the plant locally or occasionally, and which growers should be able to distinguish from the more destructive species. In their life history aphids are peculiar in many respects, and each species occurs in several different forms; for this reason a short account of aphids in general is given for the information of readers not familiar with these facts. Remedial measures are described at the close of the bulletin, since similar treatments are applicable, with some variations, for the control of all the species considered.

[1] Since the well-known grape phylloxera [*Phylloxera vitifoliae* (Fitch)] is injurious principally to the roots and requires control measures radically different from those employed against foliage-inhabiting aphids, it is mentioned only incidentally in this bulletin, although its galls on grape leaves are illustrated (fig. 27, p. 36).

NOTE.—This bulletin is of interest to orchardists, vineyardists, and growers of currants and gooseberries in all parts of the United States.

APHIDS IN GENERAL.

Aphids, or insects of the family Aphididae, have a development which is remarkable in several ways. Eggs laid in the autumn hatch in the spring about the time when vegetation revives. From these winter eggs is produced a generation of females, usually wingless, which reproduce without the intervention of males (agamic reproduction), many species giving birth to living young. The adult aphids of this first generation are termed stem-mothers. The offspring of the stem-mothers (second generation) may be winged or wingless, or both forms may occur. They reproduce without the intervention of males, some species being oviparous, or egg laying, and depositing eggs which do not require fertilization for development, while others are viviparous—that is, they bring forth young alive, the eggs developing and hatching within the body of the parent.

A succession of generations may be produced in this way until the approach of autumn, when the true sexes appear and the females deposit eggs; or a species perhaps may be more or less biennial, some individuals producing true sexes only every second year. In still other species, the true sexes of which are at present unknown, reproduction without the intervention of males continues for a series of years.

The same species of aphid usually exhibits several forms, as wingless agamic females, winged agamic females, and the true sexual forms. In the last the male may be winged and the female wingless, or both sexes may be wingless. The different generations of a given species may vary more or less in appearance, and in some instances this is the case to such an extent that they appear to belong to distinct species.

Aphids feed upon sap which is sucked up through a beak pushed down into the tissues of the plant. Their presence on plants frequently is indicated by a curled and distorted condition of foliage, though this is not always so. When the insects are abundant the drain upon the plant is very great, interfering with its proper growth and development, and in extreme cases causing the death of infested parts. The leaves and shoots of plants infested by aphids are frequently seen to be covered with a black substance, as if dusted with soot. This is due to a black fungus which grows on the "honeydew" excreted by the aphids and is not especially injurious, though often objectionable as marring the appearance of the plants and fruit. Honeydew may be produced in such quantities as to coat the leaves and is attractive to various species of ants and wasps, which are

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DESCRIPTION OF PLATE I.

THE ROSY APPLE APHIS: *A*, Infested leaves and young apples, showing characteristic curling of the leaves; *B*, apples at later stage dwarfed and distorted by earlier attack of the aphids; *C*, mature aphid of first generation, pink variety; *D*, winged spring migrants going from apple to narrow-leaved plantain (*E*); *E*, narrow-leaved plantain infested by summer wingless generations; *F*, mature wingless summer aphid on plantain; *G*, fall migrants and males flying from plantain back to apple in fall; *H*, fall migrants and males alighting on apple leaves, the former giving birth to sexual females; *I*, a fall migrant; *J*, male; *K*, sexual female and eggs, the latter yellow at first, later turn black; *L*, twig showing the eggs in winter.

THE ROSY APPLE APHIS.

often seen attending the aphids or frequenting plants infested by them. The ants of themselves are not usually the cause of trouble but merely denote the presence of the aphids.

Since frequent reference must be made in the following pages to the different stages and forms of aphids, information concerning these is presented in summary form as far as present purposes require:

Winter eggs.—These are small, oval, and blackish, and occur on the twigs, around buds, under scales of bark, or elsewhere on the shoots or branches of the winter host plant.

Stem-mothers.—The aphids hatching from the winter eggs. They are the progenitors of the numerous generations which follow during the succeeding spring, summer, and fall.

Wingless viviparous females.—Wingless aphids which give birth to living young without the intervention of males.

Winged viviparous females or migrants.—Winged aphids which give birth to living young without the intervention of males and which migrate to other plants, establishing new colonies. *Spring migrants* and *fall migrants* are often to be distinguished.

The true sexes.—Males and sexual females are usually developed in the fall from the viviparous forms, the female depositing eggs to carry the species over the winter.

APPLE APHIDS.

Three or four species of aphids commonly attack the fruit and foliage of the apple, while a few more, which at present are of minor importance, are known to infest this plant. The important species to be considered are the rosy aphis, the green apple aphis, the woolly apple aphis, the apple-grain aphis, and the clover aphis.

THE ROSY APHIS.[1]

The rosy aphis infests especially the foliage surrounding the blossom or fruit clusters, and causes the leaves to curl badly. (Pl. I, A; illustration on title page.) The insects when abundant also infest the fruit stalks and newly set fruit. The little apples on the infested fruit spurs often fail to thin out, remain small, and as the season progresses become knotty and distorted according to the degree of infestation. (Pl. I, B.) In the fall these "aphis apples" (fig. 1) may be much in evidence, especially on the lower parts of the tree, during worst aphid seasons amounting to from 15 to 30 per cent of the crop. This species is very generally present in the apple-growing portions of the country and is at present the most important aphid pest attacking the foliage and fruit of this crop. On very young trees the feeding habits differ somewhat in that in addition to the foliage the aphids may attack the young shoots, causing these as they grow to become curled and twisted (fig. 2), resulting in permanent deformities which in pruning must be cut out in order that a properly formed tree may be produced.

[1] *Anuraphis roseus* Baker.

The rosy apple aphis is easily distinguished from the other forms inhabiting the apple by its color. This varies from light salmon pink to deep purple or grayish black. (Pl. I, C.) The young stem-

FIG. 1.—The rosy aphis: "Aphis apples." Note that the fruit has failed to thin out in the clusters.

mothers when first hatched from the eggs are dark green, very similar in color to the young stem-mothers of the green apple aphis. The winged forms (Pl. I, I) are dark and often appear almost black, owing to the black head and body and the large black patch upon

the abdomen. This is particularly true of the fall migrants, which appear upon the trees in the fall. These produce the orange-yellow, wingless, egg-laying females (Pl. I, K). The males are winged and similar to the fall migrants. (Pl. I, J.) The summer forms occurring upon plantain are yellowish green, with brown patches at the base of the honey tubes.

FIG. 2.—The rosy aphis: Twisted apple twig resulting from injury by this species.

SEASONAL HISTORY.

The eggs of this species are deposited on the apple in the fall. They are light yellow when laid and change from green to polished black. They are placed upon the twigs, in the axils of the buds, or in crevices in the bark, but sometimes they are laid upon the larger branches. (Pl. I, L.) They begin hatching at about the time the buds are breaking in the spring. (Pl. III.)

FIG 3.—The rosy aphis: Condition of the foliage in spring when leaves curled by this insect are first in evidence.

The young stem-mother immediately begins feeding upon the bursting buds, and as the young leaves develop they curl about her. (Fig. 3.) Usually in 15 days the stem-mother is mature, whereupon

she begins producing young at an average of 6 a day. The stem-mother lives from a month to six weeks.

The offspring of the stem-mother may either become winged or remain wingless, and this condition may continue for at least 7 generations, so that during these generations both winged and wingless forms are to be found upon the apple. Occasional colonies of wingless forms may be found throughout the summer upon the apple. The winged forms, however (Pl. I, D), when mature fly to plantains and settle upon the underside of the leaves, or upon the flower stems, where they produce young (Pl. I, I, E). They live principally upon the species known as rib grass, long-leafed plantain, or buckhorn plantain.[1] This migration to the plantains continues, in the vicinity of Washington, from the middle of May until the first part of July. On the plantains the insects continue to reproduce during the summer months. Most of the forms produced on these plants are wingless, although a few winged ones occur throughout the summer. The color of these forms is yellowish green, in contrast to the pink or rosy color of those upon the apple. From 4 to 14 generations of the summer forms occur upon plantain in the vicinity of Washington.

In the middle of September winged forms, consisting of fall migrants (agamic females) and males, begin to appear upon the plantains. These winged forms are able to live and reproduce only upon apple trees or closely related species. The fall migrants leave the plantains and settle upon the underside of the apple leaves (Pl. I, H), where they produce the young egg-laying females. These egg-laying females are wingless and orange-yellow (Pl. I, K). The males, which are similar in color to the fall migrants, often being nearly black, fly from the plantains and find the egg-laying females upon the trees. Here mating takes place and the females deposit their eggs about the middle of October. As later females are produced by later migrants, egg-laying continues until freezing weather has killed all the females.

THE GREEN APPLE APHIS.[2]

The green apple aphis lives on the apple throughout the year, and infests the tender terminal growth, causing the leaves to curl, as shown in Plate II, J, and figure 4. In young orchards by midsummer the shoots and leaves of the trees may be more or less generally

[1] *Plantago lanceolata.*

[2] *Aphis pomi* De Geer.

DESCRIPTION OF PLATE II.

THE GREEN APPLE APHIS: *A*, Apple twig in spring with healthy young leaves; *B*, a leaf yellowed by attack of young aphids; *C*, a twig badly infested, showing sickly and stunted opening leaves; *D*, young aphid of first generation; *E*, mature aphid of first generation, a stem-mother; *F*, *G*, young and mature aphids of wingless summer generations; *H*, winged aphid of summer generations; *I*, wingless summer form, side view showing the sucking beak; *J*, terminal shoot of young tree with late summer infestation of aphids; *K*, a leaf from *J* showing aphids and their shed skins on under surface; *L*, a male aphid, produced only in fall; *M*, a sexual female, produced only in fall; *N*, eggs, yellowish when first laid, turning through green to black.

DESCRIPTION OF PLATE III.

GREEN APPLE APHIS ON OPENING APPLE BUDS: Winter eggs and newly hatched aphids on opening apple buds; young aphid much enlarged at right.

THE GREEN APPLE APHIS.

A. HOEN & CO. LITH. BALT. MORE.

GREEN APPLE APHIS ON OPENING APPLE BUDS

infested, often so much so as decidedly to check the growth. Such trees are likely to be more or less sooty in appearance and overrun with ants. Water sprouts and the shoots of top-worked trees are especially liable to attack. This is the species commonly present on the shoots of apple nursery stock, and much complained of during some years. The work of this aphid is at times confused with that of the apple leafhopper,[1] which distorts the leaves in a manner more or less similar.

The green apple aphis is uniformly green, with black legs, feelers, and honey tubes. (Pl. II, E, G, I.) Occasionally forms are met which are yellowish, instead of a distinct green. The winged forms (Pl. II, H) have a black head and body and a uniformly green abdomen. The males and egg-laying females, which are met during the fall, are somewhat smaller and different in color from the agamic forms (Pl. II, L, M) which occur throughout the summer. The males are orange yellow, sometimes with a brownish tinge, and the females dark green.

FIG. 4.—The green apple aphis: Curled condition of apple foliage due to this insect.

SEASONAL HISTORY.

The eggs when first laid are yellowish green, later turning to polished black. They are laid in the fall upon the smooth twigs and water sprouts of the apple (Pl. II, C; Pl. III; fig. 5), and seem to be laid rarely on the trunks and larger limbs. A very small percentage of the eggs of this species, sometimes as low as 2 per cent, hatches. Hatching occurs at about the same date in the spring as in the case of the rosy aphis.

The young stem-mothers mature in about 10 days, and in about 24 hours after becoming adult begin to produce living young, reproduction continuing for about two weeks. Between 40 and 50 living young are produced by each stem-mother, at the average rate of 4 a day, although many more may be born daily. Of these young

[1] *Empoasca mali* Le Baron.

some develop into winged forms, or migrants (Pl. II, H), and some remain wingless (Pl. II, E, G, I). They mature in a little over a week, and in turn produce either winged or wingless forms. Occasionally another form, intermediate between the winged and the wingless forms, is seen. This reproduction continues throughout the summer, from 9 to 17 summer generations occurring before the sexual forms appear. The true sexes, therefore, appear from the tenth to the nineteenth generation, depending upon the rate of reproduction of their ancestors and upon the time of their birth—that is to say, whether they are early or late young of the parents.

The egg-laying females become adult in from 6 to 16 days, depending upon weather conditions. When adult they mate with the males and begin depositing their eggs upon the apple twigs. Females may be found on the trees until all the leaves have fallen, even when the weather is very cold.

THE APPLE-GRAIN APHIS.[1]

The apple-grain aphis, or the apple-bud aphis, has been confused in this country with the oat aphis [2] or European grain aphis, an insect which is not common here but which occurs in Europe on the bird cherries. Both insects spend the summer on grains and grasses and on these plants look very much alike, but the apple-grain aphis lives during the winter months on apple and not on cherry. It is the earliest apple aphid to hatch in the spring; and as it often occurs in great abundance upon the buds and young foliage, it is frequently the cause of alarm on the part of orchardists. The species probably does not cause important injury, since it migrates from the apple shortly after the blossoms fall. (Pl. IV, A, B, C, D.)

When first hatched the stem-mothers are very dark green, and they remain this color until after the first molt, when they become much paler. The adult wingless forms are pale green (Pl. IV, E), with rusty areas around the base of the honey tubes, although in the summer some individuals become slightly purplish. The winged forms have black head and body with a green abdomen which is marked with black patches along the sides. (Pl. IV, F.) The honey tubes, antennæ, and feet are black. The egg-laying females, which occur in the fall, have an olive cast. (Pl. IV, N.)

SEASONAL HISTORY.

During warm days in winter many of the eggs of this species hatch on the trees, but it is not until about the middle of March, in the vicinity of Washington, that those hatching succeed in escaping destruction and produce stem-mothers. In fact, aphids from eggs hatched before April 1 are sometimes all killed by cold. The important hatching, therefore, commences after April 1.

[1] *Rhopalosiphum prunifoliae* (Fitch). [2] *Rhopalosiphum padi* (L.) (*avenae* Fab.).

The young stem-mothers of this species usually are abundant upon the swelling apple buds (Pl. IV, A), and when these begin to open the insects crowd down among the bursting leaves. By the time the stem-mothers are adult—usually in about 13 days—many of the buds have opened and the leaves expanded. Each stem-mother produces about 100 young, and these migrate to the blossoms and to the underside of the leaves, which become coated with them. (Pl. IV, D.) These young may become either winged or wingless adults (Pl. IV, E, F), and at least four generations may be produced upon the apple. The wingless forms upon apple become mature in about seven days, and each individual produces about 75 young. The period of reproduction lasts a little over two weeks, and the insects live about a month.

FIG. 5.—The green apple aphis: Winter eggs on apple twig. Much enlarged.

The winged forms produced upon apples become mature in a little over 8 days and then fly to grain and grasses, as wheat, oats, etc. (Pl. IV, G, H, O.)

In the autumn migrants are produced on grains. (Pl. IV, L.) These mature in about 2 weeks and return to the apple, the migration lasting 3 or 4 weeks, since not all the migrants are produced in the same generation. (Pl. IV, J, L.) During their life of some 6 weeks these migrants produce about 5 egg-laying females each.

The winged males are produced upon the summer food plants and migrate to the apple leaves to mate with the sexual females. (Pl. IV, M, N.) After the female has become fertilized she deposits her eggs in crevices of the bark of the larger branches or behind the bud scales of the young twigs of the apple. (Fig. 6.) The length of life of each sex depends upon weather conditions. This is particularly true of the female, which sometimes lives for weeks in a more or less dormant state during cold weather. In warm climates the species may hibernate as wingless females upon the summer hosts.

THE CLOVER APHIS.[1]

The clover aphis, first found injurious to the apple in Colorado, is now known to occur abundantly in some regions in the East. It attacks the apple in a way similar to the green apple aphis, but since there is a considerable migration of individuals to clover, it is less abundant on the apple in summer than the latter species. The stem-mothers of the clover aphis are pink and the individuals of the next generation are yellowish green. The winged forms have a large black patch on the abdomen and in this way resemble the migrants of the rosy aphis. The two species, however, can be distinguished readily by the length of the honey tubes. In the rosy aphis these are very long, while in the clover aphis they are short. The forms of this species which live on clover are pink. (Fig. 7.)

FIG. 6.—The apple-grain aphis: Winter eggs on bark of apple tree. Much enlarged.

SEASONAL HISTORY.

The eggs of the clover aphis are laid upon the apple in much the same manner as those of the species already mentioned. The stem-mothers, which are hatched considerably earlier than those of the rosy aphis and the green apple aphis, give birth to winged and wingless forms, which in turn produce young, some of which become winged, while the others remain wingless. As a rule most of the insects have become winged by early summer, although some wingless colonies occur during the summer on apple. These winged forms fly to clovers, and settling upon the stems produce wingless young. These and succeeding generations, which may contain winged individuals, pass down to the crown of the clover plants, and here the species lives throughout the summer. During October numerous fall migrants are produced upon the clovers and fly to the apple, where they give birth to the young egg-laying females. Winged males produced upon the clovers follow the fall migrants to the apple, and here mate with the females, which later deposit their eggs.

[1] *Anuraphis bakeri* (Cowan).

DESCRIPTION OF PLATE IV.

THE APPLE-GRAIN APHIS: *A*, Opening apple bud in spring infested with young aphids. The empty egg shells are seen still adhering to the twig; *B*, young aphids, more enlarged; *C*, the leaves unfolding in the bud; *D*, infested blossoms; *E*, a full-grown aphid of the first generation from the blossoms (*D*); *F*, a winged aphid, or spring migrant, from the next generation on the apple leaves; *G*, flight of spring migrants from apple to grain (*H*); *H*, oats infested by summer generations of aphids which are mostly wingless; *I*, wingless summer form; *J*, flight of fall migrants and males from grain back to the apple (*K*); *K*, fall migrants and males alighting on apple leaves, the fall migrants giving birth to the sexual females; *L*, a fall migrant; *M*, a male produced on apple in fall; *N*, sexual females showing extreme color varieties, and eggs which are pale when laid, but later turn black; *O*, wingless aphids that remain about the roots of the grain when the winter is not too severe.

THE APPLE-GRAIN APHIS.

THE WOOLLY APPLE APHIS.[1]

The woolly apple aphis is often in evidence in summer on the trunk, branches, and twigs of the apple as bluish-white cottony patches (fig. 8) which hide the rusty or purplish brown aphids beneath. While principally injurious to the roots of the apple, its injuries above ground are at times quite important. In orchards grown under arid or semi-arid conditions in the West it is decidedly more troublesome than in the East, attacking the tree wherever the bark is tender and sometimes infesting the stems of the leaves and fruit. Its injuries above ground often result in galls or swellings similar to those on the roots, and when the fruit spurs are invaded the fruiting capacity of the tree may be interfered with seriously.

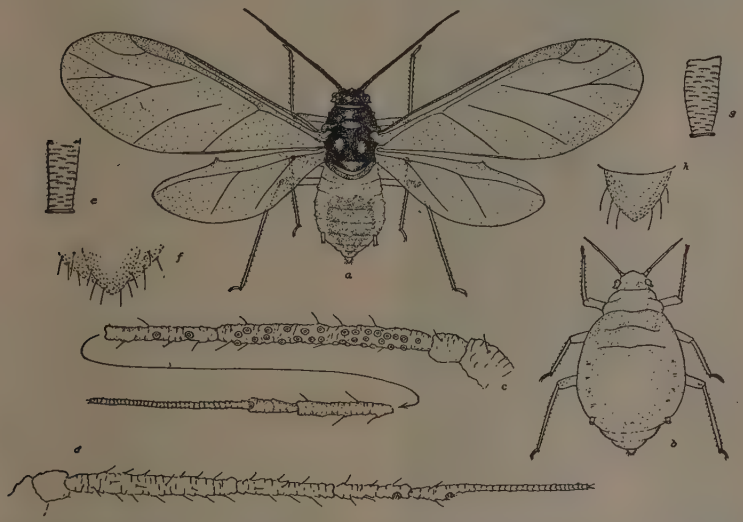

FIG. 7.—The clover aphis: *a*, Spring migrant; *b*, stem mother; *c*, antenna of spring migrant; *d*, antenna of wingless form; *e*, cornicle of spring migrant; *f*, cauda of spring migrant; *g*, cornicle of wingless form; *h*, cauda of wingless form. *a*, *b*, Much enlarged; *c–h*, more enlarged.

The usual contact sprays will be effective in destroying this pest on the limbs and branches. Its treatment on the roots of the apple requires essentially different methods, which are not considered in this bulletin.

APPLE APHIDS OF MINOR IMPORTANCE.

Several additional species of aphids are found upon the apple, but these are at present of minor economic importance.

The potato aphis [2] has been found feeding upon the apple occasionally in the spring. Its normal winter host appears to be the rose. This form is very much larger than the others mentioned, and the winged form, as well as the wingless one, is uniformly light greenish.

[1] *Eriosoma lanigerum* (Hausm.). [2] *Macrosiphum solanifolii* (Ashm.).

Another species, which is slaty blue or black, with white bands upon the legs, and often possesses white waxy tufts, occurs sometimes upon the apple. This is the dock aphis.[1] The apple does not seem to furnish suitable food to these insects, for after a few generations they always leave the trees.

FIG. 8.—The woolly apple aphis: Colonies on apple shoots.

A second dark brown or blackish species which occurs occasionally upon the apple is the bur-clover aphis.[2] It is sometimes encountered during the spring upon apple foliage.

Still another species, the wild-carrot aphis,[3] occurs commonly on the apple in the fall, particularly as the winged form. Its summer hosts are the wild carrot and related plants, and the winged forms fly to honeysuckle vines, but occasionally select apple trees.

The thorn-leaf aphis[4] also is found occasionally upon the apple. Its life history is discussed under aphids attacking the quince.

QUINCE APHIDS.

Two species of aphids which have been discussed under apple occur commonly also upon quince foliage—namely, the green apple aphis and the apple-grain aphis. Their life histories are similar on quince and apple, and the same remedial measures apply.

THE THORN-LEAF APHIS.

The thorn-leaf aphis,[4] called also the long-beaked clover aphis, is most common upon hawthorn trees. Although first found upon thorn, it is not uncommon upon quince leaves. It resembles very closely the clover aphis as found upon apple, but can be distinguished from that insect by its long beak.

On thorn trees the feeding of this species results in a curling of the leaves which is very conspicuous, the twisted leaves taking on a purplish cast. On quinces, however, it does not curl the leaves, or at least not to such an extent.

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[1] *Aphis rumicis* L.
[2] *Aphis medicaginis* Koch.
[3] *Hyadaphis xylostei* (Schrank).
[4] *Anuraphis crataegifoliae* (Fitch).

SEASONAL HISTORY.

The eggs of this insect are laid in the fall upon the twigs of the quince, and the stem-mothers hatch in the early spring. By early summer the insects are abundant and winged forms are being produced. This production of winged forms, or migrants, continues until late summer. The migrants fly from their winter hosts to clovers and peas and produce numerous generations on these plants in a manner very similar to that of the clover aphis. In the fall, migrants are produced which return to the quinces and produce the egg-laying females, which after mating with the males deposit the winter eggs. The flight of the insects from clover begins in September and extends throughout October.

PEAR APHIDS ATTACKING THE FOLIAGE.

Several species of aphids are found upon pear foliage. Most of these, however, occur also upon other trees and are treated elsewhere in this bulletin. The more common forms upon pear are the green apple aphis, the apple-grain aphis, and the clover aphis.

Another species, the woolly thorn aphis,[1] is common in some localities. Both winged and wingless forms are covered with a white, waxy substance. The wingless forms are pale green and the winged forms have a black head and body. The insects hatch in the early spring and soon attack the leaves, curling and twisting them. During early summer the winged forms leave the pear tree. In the fall migrants may be found again, and these produce the sexual forms, the females of which lay their eggs upon the bark. Besides attacking pear, this species occurs upon thorn, quince, and Juneberry.

Two other forms are found commonly upon pear, but these occur upon the roots, and since they are seldom found upon the branches and foliage and require different remedial measures, they are not treated in this bulletin. The first of these is the woolly pear aphis,[2] which is common in the western part of the country, and the second is Fitch's pear root-aphis,[3] which is very similar to the woolly thorn aphis and occurs in the eastern United States.

PLUM APHIDS.

Three or four species of aphids are common on the plum, two of which are, during some seasons, very injurious. Many complaints of injury to Japanese and native plums by the rusty plum aphis have come from the more southern States, while the mealy plum aphis is more often prevalent in the North and West, on Domestica, or the European type of plums. The hop aphis, according to records of the Bureau of Entomology, has not occasioned much injury to plums in recent years, although in the Pacific Northwest it continues to be a pest of importance to hops.

[1] *Prociphilus corrugatans* (Sirrine). [2] *Eriosoma pyricola* B. & D. [3] *Prociphilus fitchi* B. & D.

THE RUSTY PLUM APHIS.[1]

The rusty plum aphis was discovered and named from individuals feeding on grass, but is better known by its injuries to plums. It is rusty brown or deep purplish, with white bands upon the legs.

This species feeds upon the tender twigs and foliage of the plum and also upon the peach. The first stem-mothers attack the buds just as they are expanding in the spring and later crawl down among the opening leaves. As the season advances whole twigs or small branches may be literally crowded with the aphids (fig. 9), and such twigs usually die. Another species, not yet named, also has this habit, and this form may be very injurious to the twigs, as it remains on the plum throughout the summer.

FIG. 9.—The rusty plum aphis: Colony on shoot and foliage of plum.

SEASONAL HISTORY.

The eggs of the rusty plum aphis hatch early in the spring and the normal life period of the stem-mother is about a month. During this time she produces young at the rate of four to six a day. In a little over a week these young are mature and reproducing, so that large colonies soon result. A few winged forms occur in the early generations, but it is not until late spring that a large percentage of spring migrants is found. These winged forms fly from the plum and settle upon various grasses, where they produce colonies throughout the summer around the crowns of the plants. In October the fall migrants are produced upon the grasses, return to the plum, and there give birth to the egg-laying wingless females. The males also produced upon the grasses, migrate to the plum in order to locate and fertilize the egg-laying females. In some regions the species seemingly lives on the plum throughout the year.

[1] *Hesteroneura setariae* (Thos.).

THE LONG-BEAKED THISTLE APHIS.[1]

In some localities the long-beaked thistle aphis is abundant on plum trees. In structure this species most closely resembles the rusty plum aphis. The insects are shiny green and black, some of the wingless ones and all of the winged ones having a large black patch on the abdomen. (Fig. 10.)

Although this species becomes very abundant on the trees, it does not curl the leaves to any extent. Trees have been observed in the vicinity of Washington with the underside of nearly every leaf thickly covered with the insects, and yet these leaves were rolled only slightly from the edges. The insects always feed on the underside of the leaves or on the very tender twigs. Practically all the injury done to the trees is by the spring forms, the fall migrants being scattered.

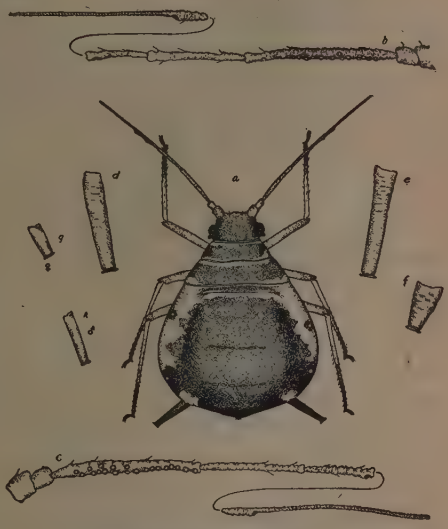

FIG. 10.—The long-beaked thistle aphis: *a*, Wingless female; *b*, antenna of spring migrant; *c*, antenna of fall migrant; *d*, cornicle of fall migrant; *e*, cornicle of spring migrant; *f*, cornicle of stem mother; *g*, cornicle of egg-laying female; *h*, cornicle of male. *a*, Much enlarged; *b*–*h*, more enlarged.

SEASONAL HISTORY.

The eggs of this species are laid upon the plum, as are those of the rusty plum aphis. In the early spring the stem-mother hatches and gives birth to living young. Winged forms begin to appear as early as the second generation and continue to be produced until midsummer. These migrate to thistles, where they produce the first of the summer forms. After having produced numerous generations on the thistle during the summer, fall migrants are produced which return to the plum trees to deposit the young egg-laying females. These, after being fertilized by the males, lay the winter eggs.

THE WATER-LILY APHIS.[2]

Plum trees are sometimes thickly infested by an aphid with swollen honey tubes, the water-lily aphis. The insects are brownish, the winged forms having a black head and body.

[1] *Anuraphis cardui* (L.).

[2] *Rhopalosiphum nymphaeae* (L.).

The spring forms feed upon the underside of the leaves or on the tender twigs of the plums, but they do not curl the leaves to any extent. The summer feeding habits of the species on water plants are very interesting, as colonies often are partially submerged for some time without apparent injury.

SEASONAL HISTORY.

The stem-mothers of this species hatch early in the spring upon the plum, and soon the young produced cover the lower side of the leaves and the twigs. Winged forms are found during June and these fly to various water plants, on which they reproduce and live during the summer months. In the fall the migrants return to the plum and produce the egg-laying females, which, when adult, are fertilized by the winged males. The flight of the fall migrants and males extends over a long period, the males having been found on the plum trees from early until late fall.

THE HOP APHIS.[1]

A large green aphid, the hop aphis, is in some regions very common upon plums in the spring. The wingless forms are light green and the winged forms are light green with black head and body and a patch of the same color on the abdomen.

The stem-mothers of this species feed upon both the flower buds and the leaf buds of the plum. After the leaves have expanded, the insects attack the underside of the leaves and often may be found thickly crowded thereon.

SEASONAL HISTORY.

The eggs hatch on the plum twigs considerably later as a rule than those of the thistle aphis. The young stem-mothers soon develop and begin the production of young. Winged forms soon appear, the greater number of these occurring in the third generation. These winged forms fly to hop vines, where they produce young that feed upon the hop plant. Eight or more generations of these summer forms are produced upon the hop, and winged fall migrants are then produced, which return to the plum trees to produce the sexual females. Males appear during the fall for a period of several weeks, the last ones usually occuring late in October or in November. These fertilize the egg-laying females, which then lay their eggs upon the twigs.

In some cases the species is able to complete its life cycle on the hop and does not necessarily alternate with the plum, whereas in other cases it remains all summer upon the plums.

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[1] *Phorodon humuli* (Schrank).

THE MEALY PLUM APHIS.[1]

The mealy plum aphis is a common form on plum trees and it can be distinguished from the other species attacking plum foliage by its uniform green color and the fine, white, powdery covering of the body. The honey tubes also differ in that they are very short.

FIG. 11.—The mealy plum aphis: Infested plum foliage.

SEASONAL HISTORY.

These insects feed upon the underside of the leaves, often being very closely packed together. (Fig. 11.) As a rule they do not curl the leaves, even when present in great numbers.

The stem-mothers of this species hatch from the winter eggs on the plum early in the spring and in about 10 days they are mature.

[1] *Hyalopterus arundinis* (Fab.).

They then give birth to young, and these when grown produce others until the leaves are often thickly covered with the insects. Winged forms develop toward late spring and continue to appear until late midsummer or later. These winged forms migrate to certain grasses and produce numerous generations during the summer. In the fall return migrants are produced, which give birth to the egg-laying forms on the plums. These migrants first appear in early September, but continue to arrive until late October or early November.

THE HAWKWEED APHIS.[1]

The hawkweed aphis is a native of Europe, where it lives on plums. In India it is very injurious to peaches and is there known as the peach-curl aphis. It has recently been found in numbers in our western region on plums. The winged forms have a black head and thorax and a green abdomen with a large black patch on it. The honey tubes are short. The wingless forms are green. (Fig. 12.)

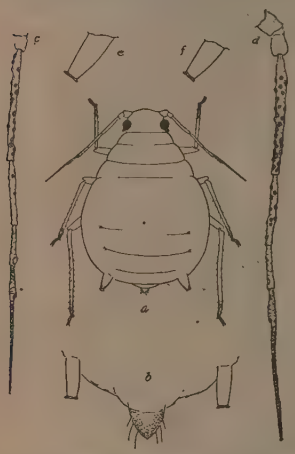

FIG. 12.—The hawkweed aphis: *a*, Wingless form from plums; *b*, cornicles of the spring migrant; *c*, antenna of summer winged form; *d*, antenna of spring migrant; *e*, cornicle of summer wingless form; *f*, cornicle of spring wingless form. *a*, Much enlarged; *b–f*, more enlarged.

SEASONAL HISTORY.

The eggs are laid upon plum trees and in the spring hatch to the greenish stem-mothers. These produce wingless forms and in late spring the winged ones may be found. These winged ones migrate to hawkweed, scorpion-grass, groundsel, etc., and produce summer colonies on these plants. In the fall winged migrants return to the plums and deposit the wingless egg-laying females. The winged males follow and mating takes place on the plums, peaches, etc. In this country the insect has not been found to be injurious to peaches, but it may become so in time.

CHERRY APHIDS.

THE BLACK CHERRY APHIS.[2]

The black cherry aphis is an abundant species almost everywhere upon cherry trees. The wingless insects have a rounded abdomen, which gives them a more or less globular appearance. Both wingless and winged forms are shining deep brown to black, while the

[1] *Anuraphis helichrysi* (Kalt.). [2] *Myzus cerasi* (Fab.).

color of the young ranges from amber through various shades of brown. The young stem-mothers are deep greenish.

On account of their early hatching in spring the young stem-mothers do not find leaf food available. They therefore attack the buds even before these show any signs of bursting. Sometimes

FIG. 13.—The black cherry aphis: Curled terminal cherry leaves following attack by this species.

the stem-mothers will feed in this manner for nearly a week before the buds begin to open. As soon as the leaves are formed the young insects attack them and cause them to curl. As they spread from leaf to leaf a large and conspicuous cluster of curled-up leaves (fig. 13) is formed, within which the insects feed.

SEASONAL HISTORY.

The eggs are laid upon the cherry twigs in the fall and hatch early in the spring. The insects are able to withstand freezing

weather, and after the return of warmer weather continue their activities. Within two or three weeks after hatching the stem-mothers are mature and produce young. These later generations become adult usually in less than a week. Some of the insects so produced become winged while others remain wingless.

The winged forms migrate to pepper-grass and other related plants and here they form colonies throughout the summer. The number which migrate varies in different parts of the country. In some regions there is a very distinct and complete migration, while in other places the wingless forms remain.

The wingless ones continue reproduction, and sometimes give rise to as many as 11 generations before the end of July. The numbers on cherry, however, gradually diminish, and during midsummer very

FIG. 14.—The chokecherry aphis: Spring migrant. Much enlarged.

few are seen upon the trees, and in some cases no insects can be found upon trees which earlier in the season were badly infested. During October fall migrants and winged males may be found returning to cherry trees and are often encountered during the migration period in larger numbers than might be expected. The fall migrants produce the egg-laying females which, when mature, are fertilized by the males.

THE CHOKECHERRY APHIS.[1]

The chokecherry aphis is found abundantly upon chokecherries and related trees. It is a pale green insect and is conspicuously mealy. The winged forms have a black head and body.

The feeding habits of this species are very similar to those of the black cherry aphis. The leaves of the terminal twigs are attacked and twisted by the feeding of the insects, entire twigs sometimes being destroyed.

[1] *Aphis cerasifoliae* Fitch.

SEASONAL HISTORY.

As in the case of the black cherry aphis, the eggs of this insect are laid on the cherry twigs. After the stem-mothers have become mature and produced young, these latter crowd the terminal leaves. Winged forms (fig. 14) are produced during early summer, and by midsummer the insects usually have disappeared from the trees. The winged forms migrate to grains and grasses and here produce colonies which are very similar to those of the apple-grain aphis. Here they live throughout the summer, and in the fall winged forms return to the cherry trees to deposit the egg-laying females.

THE CHOKECHERRY-GRAIN APHIS.[1]

The chokecherry-grain aphis is very similar indeed to the oat aphis of Europe and it is not improbable that it is the same species. The wingless forms (fig. 15) are a dark olive green, irregularly mottled with a darker color and dusted with a whitish powder, especially along the sides of the abdomen and in the abdominal wrinkles. The winged forms have the head and thorax shiny black, and the general body color dark olive with black markings on the abdomen and black honey tubes. The pupa, which later becomes the winged form, has powdery tufts along the sides and across the hind part of the abdomen. The insect attacks the terminal twigs of the chokecherry and causes a twisting and curling of the leaves. (Fig. 16.)

FIG. 15.—The chokecherry-grain aphis: Summer wingless form. Much enlarged.

SEASONAL HISTORY.

The complete life history has not been worked out. Undoubtedly the eggs are laid upon the cherry and hatch to stem-mothers, which with their young cause the curling of the leaves. Winged forms appear in June and continue to be produced for some weeks. These migrate to grains and produce colonies there somewhat similar to those of the apple-grain aphis. On the grains, however, the insects do not possess the mealy covering seen on the cherry forms. In the fall migrants return from the grains and grasses to the cherry and here produce the oviparous females which lay the overwintering eggs.

THE RED AND BLACK CHERRY APHIS.[2]

The red and black cherry aphis lives in dense red masses on the young shoots of the black cherry. It does not attack the leaves, but

[1] *Rhopalosiphum pseudoavenae* (Patch). [2] *Aphis tuberculata* Patch.

confines itself to the shoots. The species has been recorded only from Maine. In colonies found on wild cherry in the District of Columbia a few insects have been seen along the midrib of the leaf. The wingless forms have a light red body dusted with a whitish powder. The legs, honey tubes, and some spots along the sides of the abdomen are black. The winged forms have the head and thorax black and the abdomen red. The life history is unknown.

FIG. 16.—The chokecherry-grain aphis: Work on chokecherry leaves. (Maine Agricultural Experiment Station.)

THE SMALL CHOKECHERRY APHIS.[1]

A very small species lives on the chokecherry in Maine. It resembles the apple-grain aphis in appearance, except for the fact that the honey tubes have no swelling. Its life history is unknown.

[1] *Aphis furcata* Patch.

PEACH APHIDS.

THE GREEN PEACH APHIS.[1]

The green peach aphis is a common form upon peach trees. The stem-mothers in spring, as well as the fall egg-laying females, are often pinkish, and at other times light green. The wingless agamic form also is light green, while the winged individuals have a black head and body and a large dark-brown patch on the abdomen. This marking occurs upon both the spring migrant and the fall migrant. They are similar in other respects, excepting that the fall form has the honey tubes somewhat swollen.

On the peach this species feeds entirely upon the leaves, on which the insects may be found in large numbers crowded on the underside. (Fig. 17.) It has a large number of other food plants, including numerous garden vegetables.

FIG. 17.—The green peach aphis: Colony on underside of peach leaves. Much enlarged.

SEASONAL HISTORY.

The eggs of this aphid are laid upon the peach twigs, and early in the spring before the buds are opened the green stem-mothers are hatched. From this form during the spring may be produced one or more generations of wingless individuals upon the leaves. Spring migrants, however, begin to occur very early and continue to appear until the middle of June. These fly to a large number of different plants, where numerous generations occur throughout the summer. During September and October fall migrants are developed which return to the peach, where they deposit the young egg-laying females. These are fertilized by the winged males, which also have returned to the peach, and the females then lay their eggs upon the twigs. Occasionally, however, migrants are found which do not return to the peach, and these deposit egg-laying females upon the summer host plants.

[1] *Myzus persicae* (Sulz.).

THE BLACK PEACH APHIS.[1]

The well-known black peach aphis is injurious to the twigs, shoots, and roots. It is shiny dark brown to black, with the young an amber color.

The insect lives throughout the year on the roots of the peach and is most injurious to peach growing on sandy soils. It is prevalent in portions of Maryland and in Delaware, New Jersey, and Michigan. Individuals migrate from the roots during the warm periods in winter or in early spring and start colonies on the twigs and young shoots. (Fig. 18.) Often these become so numerous as to cause the death of dormant-budded nursery trees (fig. 19) and do serious or fatal injury to young orchard trees. In mild climates the insects may exist all winter on the twigs, reproducing during periods of warmth, though the twigs are for the most part reinfested each year from the insects below the soil.

FIG. 18.—The black peach aphis: Colonies on peach shoot in early spring.

The complaints of serious injury by this species on the roots of orchard peach trees, in the experience of the writers, have not been justified, the unthrifty condition of the trees being in most cases due to other causes.

SEASONAL HISTORY.

The complete seasonal history of this species is not known. The number of young produced by a given parent varies greatly, depending upon weather conditions. Sometimes only one young aphis a day will be produced, with a total of 25 or 30 young to a mother, while under favorable conditions as many as 12 young

[1] *Anuraphis persicae-niger* (Smith).

may be produced in a day and considerably over 100 as the total for a given parent. In spring large numbers of winged forms (fig. 20) appear and the percentage of these gradually increases until all

FIG. 19.—The black peach aphis: Injury to dormant-budded peach nursery stock in the spring.

FIG. 20.—The black peach aphis: Above, winged form, much enlarged; below, antenna of winged form, more enlarged.

of the forms above ground have become winged. These fly to some plant or plants not known and are not met on peach foliage until the next year.

THE EUROPEAN PEACH APHIS.[1]

The European peach aphis (fig. 21) is one of the chief insect pests of the peach in certain parts of Europe. In this country it has been found so far only in New England. It resembles our black peach aphis in many details, but the honey tubes are much shorter and the coloring is quite different. The general color is a rusty yellow or even a pinkish and the wingless form has a row of dark brown dots along each side and a large black patch on the abdomen. This patch is, however, very often broken up into distinct transverse bands. The young are yellow.

FIG. 21.—The European peach aphis: *a*, Wingless form; *b*, cornicle of winged form; *c*, antenna of winged form. *a*, Much enlarged; *b*, *c*, more enlarged.

SEASONAL HISTORY.

The eggs are laid upon the peach twigs and the young stemmothers attack the foliage. Wingless and winged forms are produced and these reach their maximum number during late spring. During late summer their numbers diminish and in the fall wingless egg-laying forms and winged males are produced.

THE VARIABLE PEACH APHIS.[2]

The variable peach aphis is a pale yellow or green and black form which looks somewhat like the green peach aphis. It occurs in California and sometimes severely injures peach trees. Colonies are formed on the tender terminal twigs and the leaves are rolled up tightly by the attacks of the insects. (Fig. 22.) Such leaves take on a reddish tinge and suggest leaf-curl. Inside of the curled leaves, however, can be found large numbers of the aphids.

The life history has not been fully worked out, but the insect is found throughout the spring and summer on clematis, which may be its normal food plant.

CURRANT AND GOOSEBERRY APHIDS.

THE CURRANT APHIS.[3]

The currant aphis is distributed over the entire country and its injury, on account of its conspicuousness, is the occasion of much complaint. The insect causes the terminal leaves to become much distorted, and little pits or pockets are formed on the underside. (See fig. 23, *b;* fig. 24.) The upper surface of the leaves assumes a

[1] *Anuraphis prunicola* (Kalt.). [2] *Myzus varians* Davidson. [3] *Myzus ribis* (L.).

more or less reddish color, evident some distance away. When the plants are badly infested these leaves fall and the fruit becomes poor and ripens prematurely. Red currants are most subject to attack, but black currants and gooseberries also are injured.

FIG. 22.—The variable peach aphis: Work on peach. (Essig.)

The stem-mothers of the species are green, the other wingless forms (fig. 23, *a*) a yellowish green, while the winged ones have a black head and body and a large black patch on the abdomen. The eggs are polished black.

SEASONAL HISTORY.

The stem-mothers hatch from the eggs in the early spring soon after the leaves open. After completing their growth they produce young aphids which infest the lower surface of the leaves. Some of the offspring of the stem-mother are winged and these fly to mother-

worts, hedge-nettles, and related plants. Here colonies develop during the summer, augmented by winged forms produced in other generations on the currants. The wingless ones remain upon the currants and continue reproduction. In each generation some winged forms occur, but wingless individuals are present until late in July upon the bushes. In fact, occasional colonies remain throughout the summer. In the fall, during early October, migrants return to the currant bushes and deposit the sexual females. These when mature are fertilized by the winged males and the eggs are laid upon the twigs.

THE SOW-THISTLE APHIS.[1]

The sow-thistle aphis is at times quite as abundant on currants as is the currant aphis. It is somewhat similar in color but can be distinguished at once from the currant aphis by the swollen honey tubes. (Fig. 23, *c*.) In the currant aphis these are long and very slender. (Fig. 23, *a*.) The eggs are polished black. The sow-thistle aphis injures the currant in about the same way as does the currant aphis, though the infested leaves (fig. 23, *d*) do not take on a reddish coloration.

SEASONAL HISTORY.

The seasonal history of this species upon currants is very similar to that of the currant aphis. The winged forms, however, migrate to the sow thistle and upon this they reproduce. After the production of numerous generations here during the summer, fall migrants are developed which return to the currants. Egg-laying females are then produced and these are fertilized by the winged males. The eggs are laid upon the twigs at about the same time as those of the currant aphis.

THE GREEN CURRANT APHIS.[2]

A species which may be called the green currant aphis has for years occurred with the currant aphis, which it resembles closely. The wingless forms of the present species are green, whereas those of the currant aphis are yellowish. The life history, so far as is known, is very like that of the currant aphis and the two forms often may be found on the same leaf. In fact, it is not improbable that the green currant aphis is merely a dimorphic form of the currant aphis.

THE VARIABLE CURRANT APHIS.[3]

The variable currant aphis is one of the most injurious species. The stem-mother is purplish green with white honey tubes. The wingless form is dark green, tan, or dark brown, whereas the winged

[1] *Amphorophora lactucae* (Kalt.). [2] *Myzus dispar* Patch. [3] *Aphis varians* Patch.

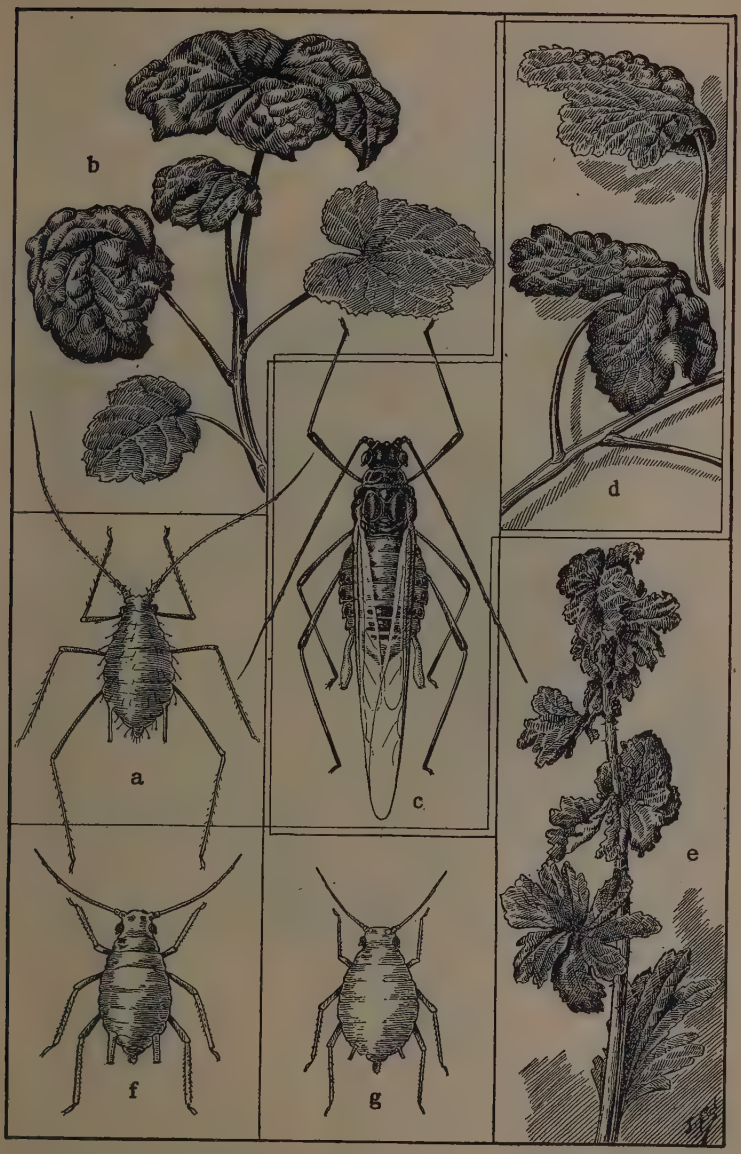

FIG. 23.—Currant aphids: *a*, Wingless viviparous female of the currant aphis; *b*, distorted currant foliage due to attack of this species; *c*, spring migrant of the sow-thistle aphis; *d*, injury to currant by this species; *e*, work of the green gooseberry aphis on gooseberry; *f*, wingless viviparous female of the New Mexico gooseberry aphis; *g*, wingless viviparous female of Sanborn's currant aphis. *a*, *c*, *f*, *g*, greatly enlarged.

form has a black head and body, with a dark green abdomen marked near the tip and on the sides with black.

As soon as the stem-mother begins to feed, the young leaf begins curling about her. As young are produced other leaves are attacked until large irregular bunches of twisted leaves occur. Later the insects attack the shoots, sometimes thickly covering them. The species infests currants, gooseberries, and flowering currants.

FIG. 24.—The currant aphis: Injury to currant foliage.

SEASONAL HISTORY.

The stem-mother hatches from the eggs early in the spring and becomes mature early in May. She produces young which are all wingless. These in turn produce young which may or may not be winged. The winged ones take flight to some unknown summer host, while the wingless ones continue the infestation upon the currants until nearly midsummer. In the fall migrants return to the currants and produce young which develop into males and egg-laying females, the latter depositing eggs upon the twigs.

THE GREEN GOOSEBERRY APHIS.[1]

The green gooseberry aphis is a green species with white honey tubes. It lives upon the underside of gooseberry leaves, which it deforms badly (fig. 23, *e*), and also upon the twigs.

The seasonal history of this species has not been determined. The winter eggs are laid upon the host plant upon which the stem-mother develops. Wingless forms occur later than the stem-mother, and winged ones also are produced upon the gooseberry.

THE NEW MEXICO GOOSEBERRY APHIS.[2]

Another species is found on gooseberries in New Mexico. The wingless forms (fig. 23, *f*) are green, while the winged forms have black head and body, with green abdomen marked with some dark bands or spots. Its life history is unknown. A variety of this species is found in California, feeding upon the red currant.

SANBORN'S CURRANT APHIS.[3]

A small species of aphid occurs in the Middle West and Southwest on Missouri gooseberries and cultivated currants. This is Sanborn's currant aphis. The wingless forms (fig. 23, *g*) are green, and the winged forms have black head, body, legs, honey tubes, and an-

FIG. 25.—The Houghton gooseberry aphis: Work on Houghton bushes.

[1] *Aphis sanborni* Patch. [2] *Aphis neomexicanus* (Ckll.). [3] *Aphis ribis* Sanborn.

tennæ. The species is found in the spring in rather large colonies on the underside of the leaves, which it causes to curl and twist.

THE HOUGHTON GOOSEBERRY APHIS.[1]

A pale green species has become prominent in recent years by reason of its attacks on gooseberries. The wingless ones are green and covered with knobbed hairs. The winged ones are dark green with a brown head and thorax. The insects attack the growing

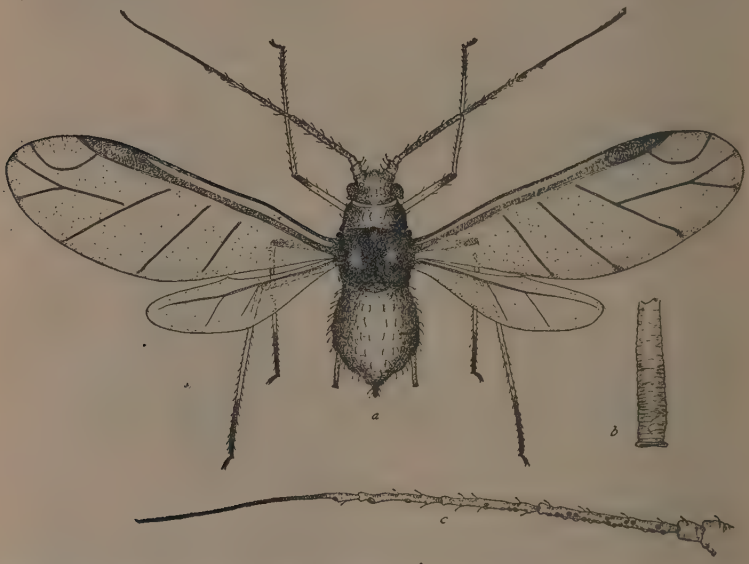

FIG. 26.—The Houghton gooseberry aphis: *a*, Winged form; *b*, cornicle of winged form; *c*, antenna of winged form. *a*, Much enlarged; *b*, *c*, more enlarged.

tips and ultimately produce a "witches broom" like that seen in the illustration (fig. 25).

SEASONAL HISTORY.

The eggs are laid on the bark under the loose folds which extend down the twigs. Occasionally also they occur on the bases of the buds or even on the thorns.

The eggs hatch with the expanding buds and the young stem-mothers place themselves on the underside of the leaves, the petioles, or tender twigs. The leaves soon curl and twist, forming a protection for the stem-mother and her young. The stem-mother and succeeding wingless forms therefore cause the twisting of the leaves.

The winged forms (fig. 26) occur in all generations from the second onward, even the stem-mother producing some winged forms.

[1] *Myzus houghtonensis* (Troop).

These winged ones leave the plants, and we have not been able to trace them farther. They begin to appear early in May.

The wingless forms carry on the infestation and in September and October the sexed forms appear. The male is very small and wingless and is slightly darker than the ordinary wingless form. The egg-laying female is somewhat larger than the male and also wingless. These mate and the female lays her eggs on the twigs a short time later.

THE ORNAMENTAL CURRANT APHIS.[1]

The wingless forms of the ornamental currant aphis are pale greenish with the honey tubes dusky at the tips. The winged forms are similar in color with pale brownish lobes on the thorax. The egg-laying female is orange in color with pale yellowish spots, while the abdomen of the male is dark.

SEASONAL HISTORY.

This species usually occurs on the ornamental currants. The eggs hatch in the spring and numerous generations of wingless forms are produced. By August these are present in large numbers on the tender terminal twigs and to a less extent on the undersides of the leaves. Winged forms appear in September or earlier and ants are found attending the insects. Early in October the orange, wingless, egg-laying females may be found mating with the winged males and the eggs are laid shortly afterward.

THE WESTERN CURRANT APHIS.[2]

This species lives on the flowering currant in California, on which it makes curls or blisters similar to those produced by the currant aphis. The wingless form is green or yellowish green. The winged form is green with black head and thorax. The egg-laying female is whitish-yellow and the male red.

SEASONAL HISTORY.

The eggs are supposedly laid on the twigs and the stem-mother appears very early in the season. The winged forms begin to appear in March and the male and egg-laying female may be found as early as the month of May.

THE DOGBERRY APHIS.[3]

The dogberry aphis is very like the Houghton gooseberry aphis. It was found on the prickly gooseberry or dogberry and occurs also on the Buffalo currant (*Ribes aureum*). It differs from the Houghton gooseberry aphis in having fewer pores or sensoria upon the antennæ, and less distinctly knobbed hairs. Its life history is not fully known.

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[1] *Macrosiphum ribiellum* Davis. [2] *Myzus ribifolii* Davidson. [3] *Myzus cynosbati* (Oest.).

GRAPE APHIDS ATTACKING THE FOLIAGE.

The well-known grape phylloxera [1] occurs in some localities upon grape foliage (fig. 27), but this species is not treated in this bulletin, since it is injurious principally to the roots and requires control

FIG. 27.—Galls of grape phylloxera on grape leaf.

measures radically different from those employed against foliage-inhabiting species.

THE GRAPEVINE APHIS.[2]

The grapevine aphis is very numerous in some localities, infesting the tender shoots and leaves (fig. 28) and sometimes the fruit clusters,

[1] *Phylloxera vitifoliae* (Fitch).

[2] *Aphis illinoisensis* Shimer.

causing the berries to drop. It can be distinguished easily from any other forms occurring on the grape by its large size and its dark-brown color.

SEASONAL HISTORY.

The eggs of this species are laid upon the twigs of the black haw.[1] Very early in the spring they begin hatching, but these first stem-mothers may be killed by frost. Six or eight weeks later the aphids of the second generation mature, and these nearly all become winged. These migrants fly to the grape and produce young upon the tender growing shoots, where in less than 10 days they are mature and producing young. Reproduction on the grape continues throughout the summer, and often more than a dozen generations may occur. In each generation winged forms are found and these carry the infestation to new vines. During October fall migrants are produced, which return to the haw trees and deposit the egg-laying females. When mature these are fertilized by the winged males which follow the fall migrants, and egg laying results.

FIG. 28.—The grapevine aphis: Colony on grape shoot.

NATURAL ENEMIES OF APHIDS.

Aphids are attacked by various species of parasitic and predacious insects and by fungous diseases, and these agencies exert a very important influence in their control. The combined effect of these several factors normally keeps the aphids pretty well reduced, but when for any reason their activities are lessened the aphids may increase enormously and do widespread injury. Heavy driving rains are believed to be inimical to aphids,

[1] *Viburnum prunifolium.*

whereas cool, cloudy weather seems to reduce the activities of the parasitic and predacious enemies, permitting the aphids to become correspondingly abundant.

Ladybird beetles (fig. 29) may be found in almost any colony of aphids, both the beetles and larvæ feeding freely on the insects. Numerous species of these beetles attack the aphids, and they should be protected and encouraged when possible.

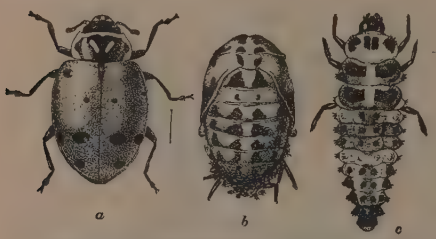

FIG. 29.—The convergent ladybird (*Hippodamia convergens*), an enemy of orchard aphids: *a*, Adult; *b*, pupa; *c*, larva. Enlarged. (Chittenden.)

Larvæ, or maggots, of syrphus flies, also called sweat flies (figs. 30 and 31), are very generally present in aphid colonies and are most important checks to their increase. The larvæ of two or three species of lacewing flies feed freely on aphids, although they are not so important as the insects mentioned above.

Probably the most important check to aphid increase, however, is the work of certain minute, four-winged flies which live parasitically on the aphids. These multiply very rapidly and under normal conditions are very effective. The bodies of parasitized aphids usually become enlarged, assume a more or less globular shape, and finally show the exit hole of the adult parasite. (Fig. 32.)

FIG. 30.—Larva of the syrphid fly *Allograpta obliqua*, an important enemy of aphids. Much enlarged. (Metcalf.)

CONTROL MEASURES.

As previously stated, aphids feed upon plant juices which they obtain by means of a beak inserted into the plant tissues. Paris green, arsenate of lead, and other arsenicals, or stomach poisons, are therefore ineffective against these insects, and the so-called contact sprays, such as kerosene emulsion, soap washes, nicotine sprays, etc., must be employed. These sprays, to be effective, must come in contact with the bodies of the insects, and great thoroughness in spraying is necessary.

Two principal plans of attack may be followed in the control of orchard aphids. Those species which winter in the egg stage on the plants to be protected may be treated with sprays early in the spring as the buds are expanding, to destroy the young stem-mothers. Treatment at this time assumes that without it the aphids would become injurious later in the season and is in the nature of insurance.

Following the other plan, spraying is not done until the insects actually have become troublesome, which does not occur as a rule until after the foliage is well out. With species that cause the leaves to curl this is too late to obtain much benefit from spraying. In view of the more or less irregular occurrence of aphids many growers will prefer to delay treatment until the insects actually are present on

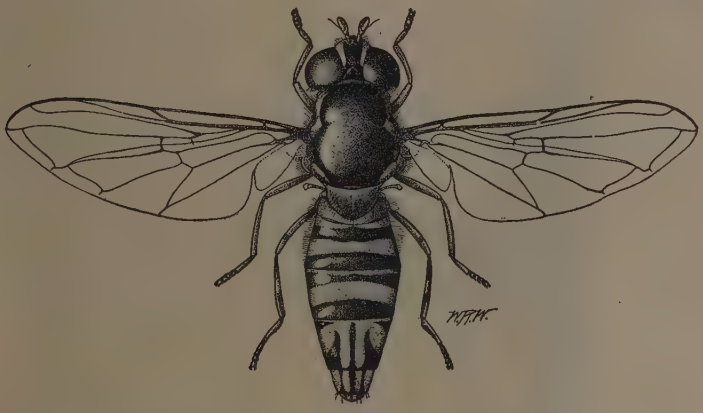

FIG. 31.—The adult syrphid fly *Allograpta obliqua*. Much enlarged. (Davis.)

the plants in destructive numbers, and in the case of those species which do not curl the leaves to any extent this plan will be satisfactory. Care should be taken, however, to treat the aphids promptly when they are found to be becoming abundant. It is a question for the grower to decide whether under his conditions danger of aphid injury, especially by the leaf-curling species, makes the bud application desirable or whether this danger is so small that he is warranted in taking chances on the insects becoming troublesome. Examination of the plants to determine the abundance of winter eggs and young stem-mothers on the opening buds should be of assistance in this connection, though abundant winter eggs are not always followed by aphid abundance, since many may succumb to unfavorable weather conditions.

INSECTICIDES.

INSECTICIDES MADE FROM TOBACCO.

COMMERCIAL NICOTINE SOLUTIONS.

Aphids are killed by surprisingly small quantities of nicotine in water, and because of the entire safety with which it may be applied to plants nicotine is better suited than other sprays to control these

insects. While the cost of the concentrated article is high, the extent to which it may be diluted makes the spray compare favorably in cost with other contact sprays. Nicotine is extracted from refuse tobacco, principally stems, by different commercial concerns, and is put on the market in several grades and strengths. The 40 per cent nicotine sulphate, containing 40 per cent of nicotine, is the solution principally used, although weaker grades of nicotine may be employed, provided care is taken that the spray be made so as to contain not less than 0.05 or 0.06 per cent of actual nicotine.

FIG. 32.—A colony of the black peach aphis on peach twig heavily infested by a species of parasitic four-winged fly. Enlarged.

Nicotine may be added either to the winter-strength lime-sulphur solution for the San Jose scale or to the dilute lime-sulphur solution and arsenate of lead spray employed in the control of insects and diseases of fruit and foliage. It may also be used in Bordeaux mixture and arsenate of lead spray without interfering with its effectiveness or in an arsenate of lead, milk of lime, and water spray. In orchard spraying the 40 per cent nicotine sulphate is used at the rate of about three-fourths of a pint to 100 gallons of water, lime-sulphur solution, or Bordeaux mixture. When used in water the addition of soap at the rate of 4 or 5 pounds to 100 gallons adds much to its spreading power and efficiency. *Soap should not be used with lime-sulphur solution, but may be used in Bordeaux mixture.* Where only a small quantity of spray is required the nicotine sulphate may be used at the rate of 1 teaspoonful to a gallon, or 1 ounce to 8 gallons of soapy water.

Homemade Nicotine Sprays.

Tobacco decoctions may be prepared readily at home, and, although varying somewhat in strength, will give as satisfactory results as the commercial products unless used too weak. The practicability of making the nicotine sprays will depend chiefly upon the availability and cost of the refuse tobacco. Tobacco stems, sweepings, and damaged tobacco are the most economical for this purpose and the dark types of tobacco, owing to their relatively high nicotine content, are preferable to light-colored tobacco. If a desirable type of refuse tobacco can be purchased at a reasonable price, the fruit grower can often make nicotine sprays profitably at home. The first cost of the tobacco waste is reduced, since, after the nicotine has been extracted, the tobacco still has a fertilizer value of about one-half its first cost.

The amount of refuse tobacco necessary to give a spray containing 0.05 or 0.06 per cent of nicotine will vary considerably, as will be noted in the following table adapted from a publication of the Virginia Agricultural Experiment Station,[1] which is given as a guide:

Formula for making nicotine extracts.

Kind of tobacco.	From—	Nicotine.	Number of pounds per 100 gallons necessary to make solutions containing different percentages of nicotine.	
		Per cent.	*0.06 per cent.*	*0.05 per cent.*
Light stems	Richmond, Va.	0.481	145	121
Do	Danville, Va.	.609	110	91
Sweepings	do	.884	74	62
N. L. Orinoco	Appomattox, Va.	5.535	12½	10½
Olive	Powhatan, Va.	3.367	19½	16¾
Light	Danville, Va.	2.984	22	18
Sweepings	Louisville, Ky.	.753	91	85
Smoker	Chatham, Va.	2.306	28½	23½
Wrapper	do	3.05	21½	18
Cutter	do	3.466	19	15
Dark	Appomattox, Va.	2.835	23¼	19¼
N. L. Orinoco	Bowling Green, Va.	5.629	11¾	10
Medium smoker	Chatham, Va.	3.766	17½	14½
Common smoker	do	2.47	26	21½

Since it is impracticable for the fruit grower to have the refuse tobacco chemically analyzed, he should approximate the class to which it belongs and use according to the foregoing table. The chief danger lies in making the solution too weak. If made stronger than necessary, no damage to the plant will result.

Methods of Making.

One of the most convenient as well as satisfactory methods of making nicotine sprays on the farm is by simply soaking the tobacco

[1] Ellett, W. B., and Grissom, J. Thomas. Preparation of nicotine extracts on the farm. Va. Agr. Exp. Sta. Bul. 208. 1914.

in the full quantity of water, with occasional stirrings, for a period of 24 hours. About 70 to 80 per cent of the nicotine will be extracted. After straining the tobacco solution to remove the particles of leaves and stems, it is ready for use.

The tobacco spray may also be made in a lime-sulphur plant equipped with steam. Place the proper amount of tobacco and water in the cooker and release the steam, and, as soon as the water reaches the boiling point, shut off the steam. As soon as the solution has cooled it is ready to use. By this method about the same percentage of nicotine is extracted as by the soaking process. The solution should never be boiled, as the nicotine is volatile.

Nicotine sprays should not be made up until they are to be used, since fermentation begins within two or three days, perhaps spoiling them for spraying purposes.

The homemade nicotine solutions, when prepared as above at the strengths indicated, will give control of most aphids. But as a matter of precaution it will be advisable to observe the effect of the spray upon the insects, and, if not effective, to strengthen it.

Tobacco Dust.

Tobacco dust has long been recommended for the control of the woolly apple aphis on the roots of the apple, and for other root-inhabiting insects, and to a less extent for dusting low-growing plants, as currants and gooseberries for the destruction of aphids.

Tobacco dust has some value as a treatment for the woolly aphis on the roots of the apple, its effectiveness varying much with the amount of nicotine in the dust and its fineness and the character of the weather. Abundant moisture in the soil, as from irrigation or rains, leaches out the nicotine, thus destroying the insects to a greater or less extent. Where tobacco dust may be obtained cheaply its use is warranted for the woolly aphis, but the purchaser should insure himself that the dust is not the grade sold for fertilizer purposes from which the nicotine has been extracted. In addition to its insecticidal value, tobacco dust has a distinct fertilizer value.

SOAP SPRAYS.

Sprays made from several kinds of soap are much used for the destruction of various soft-bodied sucking insects, particularly aphids, the pear psylla, certain plant-bugs, etc.

Commercial Fish-Oil Soaps.

The commercial fish-oil soap, formerly known under the trade name of "whale-oil soap," is usually made from fish oils combined with either caustic soda or potash and should contain not over 30 per cent of water. An average grade of a soda fish-oil soap should

contain, in addition to the water, about 10 per cent of caustic soda, 58 per cent of fatty matter as anhydrides, and about 2 per cent of other matter. Soda fish-oil soap is generally of medium to hard consistency, whereas the potash soaps are much softer. They are brownish in color, with a distinct fishy odor.

For foliage sprays the fish-oil soap is dissolved at the rate of 1 pound in 3 to 4 gallons of water or at greater dilutions, depending upon the insects to be treated and the hardiness of the foliage. Soda soaps are fairly hard and usually require slicing and dissolving in hot water.

Fish-oil soaps may be used with the following spray materials to increase their spreading and adhesive qualities: Arsenate of lead, nicotine solutions, Bordeaux mixture, and sulphur. *Do not use soap in lime-sulphur solutions, or in waters containing compounds of lime and magnesium (hard waters).*

Homemade Fish-oil Soap.

A good fish-oil soap [1] may be made at ordinary summer temperatures without the aid of external heat according to the formula given below:

Caustic soda	pounds..	6
Water	gallon..	½
Fish oil	gallons..	3¼

Thoroughly dissolve the caustic soda in the required amount of water. Then, while stirring constantly, add the fish oil very slowly and continue active stirring for about 20 minutes or until the soap is complete. The homemade fish-oil soaps may be used in about the same proportions as the commercial products.

Liquid Fish-oil Soap.

Commercial liquid fish-oil soap may be substituted for the harder fish-oil soaps. Apply according to the directions given for fish-oil soap, using 1 pint of the liquid soap in place of 1 pound of the hard soap. Liquid soaps are especially convenient in making oil emulsions.

Tobacco Fish-oil Soap.

Commercial fish-oil soaps containing a small percentage of nicotine are sold for insecticidal purposes. Soaps of this kind are somewhat expensive and their use is scarcely justified unless the nicotine is present in sufficient quantity to have distinct insecticidal value, namely, 0.05 to 0.06 per cent in the completed spray.

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[1] Van Slyke, L. L., and Urner, F. A. N. Y. Agr. Exp. Sta. (Geneva) Bul. 257. 1904.

QUASSIA AND FISH-OIL SOAP.

Quassia extracts are used for destroying certain sucking insects, especially the plum or hop aphis. Solutions containing quassiin are more effective when combined with soap, which serves as a spreader and "sticker." Various formulas with different amounts of quassia chips and soap have been used, depending upon the insects to be destroyed. The following formula gives a fairly strong spray solution:

Quassia chips	pounds	2½, or	pound	¼
Fish-oil soap	do	5 , or	do	½
Water	gallons	50 , or	gallons	5

First dissolve the soap in a little hot water and pour into the container and then add sufficient water to make the total product equal to that given in the formula. Place the quassia chips (small chips are best) in cloth sacks and submerge in the soapy liquid for 24 hours. The soap aids in extracting the quassiin. Instead of soaking the chips as above, they may be boiled in the same amount of soapy water for 4 to 5 hours. In order to extract a large percentage of the quassiin the full amount of the water indicated in the formulas should be used. Fruit growers will find no particular advantage in using quassia chips over nicotine solutions or kerosene emulsion. Quassia chips are not readily obtainable and the homemade extract, owing to its somewhat variable strength, is not always dependable.

KEROSENE EMULSION.

Kerosene emulsion has long served as a standard spray for control of soft-bodied sucking insects. If well made and properly diluted kerosene emulsion will give satisfactory results. *It should never be combined with lime-sulphur.*

A good stock solution of kerosene emulsion containing 66 per cent of oil (by volume) may be made according to the following formula:

Kerosene (coal oil, lamp oil)	gallons	2
Fish-oil or laundry soap (or 1 quart soft soap)	pound	½
Water	gallon	1

First dissolve the soap in boiling water; then remove the vessel from the fire. Immediately add the kerosene, and thoroughly agitate the mixture until a creamy solution results. The stock solution may be more conveniently made by pouring the mixture into the tank of a spray pump and pumping the liquid through the nozzle back into the tank for some minutes. The stock solution, if properly made, should last for some time, but it is better to make it up as needed. Do not dilute until ready to use. To make a 10 per cent spray (the strength for trees in foliage) add, for each gallon of the stock solution, about 5⅔ gallons of water. Agitate the mixture in all cases after adding the water.

The preparation of the emulsion may be simplified by the use of a naphtha soap. No heat will be required, as the kerosene will combine readily with the naphtha soap in water, when thoroughly agitated. If naphtha soap is used, twice as much will be required as is given for the other kinds of soap in the foregoing formula, and soft or rain water should be used in making the emulsion. In regions where the water is "hard" this should first be "broken" with a little carbonate of soda, or common lye, before use for dilution, to prevent the soap from combining with the lime or magnesia present, thus liberating some of the kerosene; or rain water may be employed.

SPRAYING FOR APPLE APHIDS.

Experiments made by the Bureau of Entomology and several of the agricultural experiment stations, notably those of Colorado and Oregon and the Geneva, N. Y., station, show that the aphids attacking the fruit and foliage of the apple are best controlled by spraying in the early spring just as the buds are breaking to destroy the stem-mothers. At this time the insects are hatching from the winter eggs, and are so exposed that one thorough treatment should destroy from 95 to 98 per cent of them and prevent their increase to such an extent that they will not cause serious injury later in the season. This applies especially to the oat aphis, the rosy aphis, and the clover aphis.

THE DELAYED DORMANT TREATMENT.

The plan is to delay the application of the winter-strength lime-sulphur solution until the buds begin to show green, and, by the addition to the spray of tobacco extract or nicotine, effect a combination treatment for the San Jose scale[1] and the aphids. Principally nicotine sulphate, containing 40 per cent nicotine, is used at the rate of ¾ pint to 100 gallons of lime-sulphur spray. The nicotine destroys the hatched aphids that are hit with the spray, while the lime-sulphur, in addition to controlling the scale, is thought to destroy a large proportion of the eggs of the aphids on the trees, should any be still unhatched.

In orchards badly infested with the scale it is doubtful whether the grower should take chances with the delayed dormant treatment, especially in large orchards where the spraying takes considerable time. Unfavorable weather or other conditions may so delay spraying operations that the foliage will develop to such an extent that the use of dormant-strength lime-sulphur would endanger the leaves. Such late spraying, furthermore, would not be as effective as desirable in destroying the aphids, since most of these would be more or less protected by the foliage or would have penetrated the expanding shoots.

[1] *Aspidiotus perniciosus* (Comst.)

Figure 33 illustrates an apple bud with aphids clustered on it in about the right condition for the delayed dormant treatment. Figure 34 shows an apple bud with leaves so far out that the aphids are pretty well protected between the leaves, and the delayed dormant application would not be very effective in killing the aphids, and might cause some foliage injury.

In the case of the green apple aphis, which lives on the apple throughout the year, the suppression of stem-mothers in the spring

FIG. 33.—Young stem-mothers of an apple aphid and condition of buds when the bud spraying should be given. Enlarged.

does not always guarantee freedom from this insect during midsummer, and supplementary treatments sometimes are desirable. In the case of young orchards, where the green apple aphis is principally to be considered, the bud spray should be given, but additional applications should be made in summer if found necessary.

Spraying in the fall for the destruction of the fall migrants and the egg-laying females has been tried to a limited extent, but the adequacy of the treatment has not yet been proven.

Annual bud spraying of apple orchards would appear to be good practice, and over a series of years would no doubt prove profitable.

This is especially true of varieties subject to "fruit spots" or "stigmonose," since these troubles have been shown by the Bureaus of Plant Industry and Entomology to be due, in part at least, to the activities of aphids.

CONTROL OF APHIDS ON PLUM, PEACH, CHERRY, ETC.

The several aphids which occur on plum, as well as the green peach aphis, pass the winter on the trees in the egg stage, hatching in the spring about the time when foliage appears. None of these species curls the foliage to the same extent as do some of the apple

FIG. 34.—Young apple shoot too far expanded for successful aphid spraying. Enlarged.

aphids, and thorough spraying of the trees when the insects are in evidence usually will be satisfactory. Nevertheless spring spraying against the stem-mothers is desirable in orchards where the insects have been troublesome regularly or where winter eggs are seen to be present in numbers.

The black peach aphis, which winters on the roots of the peach, should be treated as soon as the insects are observed to be present on the foliage and twigs, and in regions where they are likely to be troublesome, as on nursery stock in sandy situations, careful watch should be made for their first appearance.

The black cherry aphis is likely to be in evidence each year on cherries. The insect winters on the trees in the egg stage and the eggs hatch somewhat in advance of the opening of the buds. Since this species causes a decided curling of foliage so that later treatments

are not satisfactory, the effort should be made to destroy the stem-mothers as the buds are breaking.

CONTROL OF APHIDS ON CURRANT, GOOSEBERRY, AND GRAPE.

All of the important aphids attacking the currant and gooseberry pass the winter on these plants in the egg stage, the stem-mothers hatching as the leaf buds are opening and soon causing the leaves to become more or less pitted or curled. It is especially important, therefore, to spray as the shoots are pushing out, to destroy the stem-mothers before they are protected by the distorted foliage. In spraying for these insects later in the season the liquid should be directed upward to wet the insects on the underside of the leaves.

The grapevine aphis, while often abundant on the terminal growth, is rarely very injurious. It is much subject to parasitic and predatory enemies, and migrates from the grape to Viburnum in early fall. When so abundant as to require treatment, any of the contact insecticides may be used.

CLEAN CULTURE.

As the reader will have learned, most aphids have a winter and early spring host plant, and from this they migrate to other plants, on which they subsist for several weeks or months during the summer.

In most instances this alternation of food plants is essential to the life of the species, and in general the aphids are most troublesome in regions where alternate hosts are present in abundance. Often one or more of the host plants are of little or no economic importance in the locality, and in some cases are troublesome weeds. The destruction of worthless plants is desirable and should serve materially to reduce the aphids in question. Thus, in the case of the rosy aphis, the alternate food plants of which are species of plantain, the destruction of these in and about orchards is especially desirable, and should be a part of the remedial work against this pest in localities where it is more or less chronically injurious.

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